

IN THE CLAIMS:

Please amend the claims as follows.

1. (Currently Amended) A differential amplifier that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a second differential output signal, wherein the first ground emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground and ~~a first grounded base amplifier that receives the first input signal and generates a second differential output signal;~~ and

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

2. (Original) The differential amplifier according to claim 1, wherein the first and second differential output signals have reverse phases, and the third and fourth differential output signals have reverse phases.

3. (Currently Amended) ~~The~~ A differential amplifier ~~according to claim 1, that receives first and second input signals and generates first and second output signals, the~~

differential amplifier comprising:

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor,

a first resistor connected between an emitter of the first transistor and a ground,

a first capacitor connected to a base of the first transistor, for receiving the first input signal, and

a second resistor connected between the base of the first transistor and a bias voltage;

the first grounded base amplifier includes:

a second transistor,

a second capacitor connected between a base of the second transistor and

the ground,

a third resistor connected between the base of the second transistor and the bias voltage,

a third capacitor connected to an emitter of the second transistor, for receiving the first input signal, and

a fourth resistor connected between the emitter of the second transistor and the ground;

the second grounded emitter amplifier includes:

a third transistor,

a fifth resistor connected between an emitter of the third transistor and the ground,

a fourth capacitor connected to a base of the third transistor, for receiving the second input signal, and

a sixth resistor connected between the base of the third transistor and the bias voltage; and

the second grounded base amplifier includes:

a fourth transistor,

a fifth capacitor connected between a base of the fourth transistor and the ground,

a seventh resistor connected between the base of the fourth transistor and the bias voltage,

a sixth capacitor connected to an emitter of the fourth transistor, for receiving the second input signal, and

an eighth resistor connected between the emitter of the fourth transistor and the ground;

wherein a collector of the first transistor is connected to a collector of the fourth transistor, and a collector of the second transistor is connected to a collector of the third transistor.

4. (Currently Amended) ~~The~~ A differential amplifier according to claim 1, that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal, and

a first resistor connected between an emitter of the first transistor and a

ground;

the first grounded base amplifier includes:

a second transistor,

a first capacitor connected between a base of the second transistor and the ground,

a third transistor, a collector of which is connected to an emitter of the second transistor, and a base of which is connected to its own collector and receives the first input signal, and

a second resistor connected between an emitter of the third transistor and the ground;

the second grounded emitter amplifier includes:

a fourth transistor, a base of which receives the second input signal, and

a third resistor connected between an emitter of the fourth transistor and the ground; and

the second grounded base amplifier includes:

a fifth transistor, a base of which is connected to the ground via the first capacitor,

a sixth transistor, a collector of which is connected to an emitter of the fifth transistor, and a base of which is connected to its own collector and receives the second input signal, and

a fourth resistor connected between an emitter of the sixth transistor and the ground;

wherein a collector of the first transistor is connected to a collector of the fifth

transistor, and a collector of the second transistor is connected to a collector of the fourth transistor.

5. (Currently Amended) ~~The~~ A differential amplifier according to claim 1, that receives first and second input signals and generates first and second output signals, the differential amplifier comprising:

a first differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal, and a first grounded base amplifier that receives the first input signal and generates a second differential output signal; and

a second differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal;

wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal,

wherein the first grounded emitter amplifier includes:

a first transistor, a base of which receives the first input signal,

a first resistor connected between an emitter of the first transistor and a ground, and

a second transistor, an emitter of which is connected to a collector of the first transistor;

the first grounded base amplifier includes:

a third transistor,

a first capacitor connected between a base of the third transistor and the ground,

a fourth transistor, a collector of which is connected to an emitter of the third transistor, and a base of which is connected to its own collector and receives the first input signal, and

a second resistor connected between the emitter of the third transistor and the ground;

the second grounded emitter amplifier includes:

a fifth transistor, a base of which receives the second input signal, and

a sixth transistor, an emitter of which is connected to a collector of the fifth transistor; and

the second grounded base amplifier includes:

a seventh transistor, a base of which is connected to the ground via the first capacitor,

an eighth transistor, a collector of which is connected to an emitter of the seventh transistor, and a base of which is connected to its own collector and receives the second input signal, and

a fourth resistor connected between an emitter of the eighth transistor and the ground;

wherein a collector of the second transistor is connected to a collector of the seventh transistor, and a collector of the third transistor is connected to a collector of the

sixth transistor.

6. (Original) A differential converter comprising:

an input-stage differential converter including a first grounded emitter amplifier that receives an original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original input signal and generates a second differential input signal; and

a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second output signals, wherein the differential amplifier includes:

a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base amplifier that receives the first differential input signal and generates a second differential output signal, and

a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential output signal, and a third grounded base amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal.

7. (Currently Amended) A mixer that mixes first and second input signals with

first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

a differential amplifier that receives the first and second input signals and generates first and second output signals, wherein the differential amplifier includes,

a first single-end differential converter including a first grounded emitter amplifier that receives the first input signal and generates a first differential output signal and a first grounded base amplifier that receives the first input signal and generates a second differential output signal, wherein the first grounded emitter amplifier includes a first transistor and a first resistor connected between an emitter of the first transistor and a ground;

a second single-end differential converter including a second grounded emitter amplifier that receives the second input signal and generates a third differential output signal, and a second grounded base amplifier that receives the second input signal and generates a fourth differential output signal, wherein the second grounded emitter amplifier includes a second transistor and a second resistor connected between an emitter of the second transistor and the ground, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and

a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

8. (Original) A mixer that mixes an original input signal with first and second carrier signals to generate first and second mixer output signals, the mixer comprising:

- an input-stage differential converter including a first grounded emitter amplifier that receives the original input signal and generates a first differential input signal, and a first grounded base amplifier that receives the original input signal and generates a second differential input signal;
- a differential amplifier connected to the input-stage differential converter, for receiving the first and second differential input signals and generating first and second output signals, wherein the differential amplifier includes,
 - a first output-stage differential converter including a second grounded emitter amplifier that receives the first differential input signal and generates a first differential output signal, and a second grounded base amplifier that receives the first differential input signal and generates a second differential output signal, and
 - a second output-stage differential converter including a third grounded emitter amplifier that receives the second differential input signal and generates a third differential output signal, and a third grounded base amplifier that receives the second differential input signal and generates a fourth differential output signal, wherein the first output signal is generated by coupling the first differential output signal and the fourth differential output signal, and the second output signal is generated by coupling the second differential output signal and the third differential output signal; and
- a pair of differential circuits connected to the differential amplifier, for receiving the first and second output signals and the first and second carrier signals to generate the first and second mixer output signals.

REMARKS

Claims 1-8 are pending in this application. By this Amendment, claims 1, 3-5 and 7 are amended. No new matter is added. In view of the above amendments and the following remarks, Applicant requests the favorable consideration of claims 1, 3-5 and 7.

Claims 1 and 2 were rejected under 35 U.S.C. 102(b) as being anticipated by Quinn R. 31,545. The Examiner maintains his position in the Advisory Action dated June 25, 2003. Specifically, the Examiner states that the voltage sources are considered ground for small signal analysis, therefore, the amplifiers 100 and 102 as illustrated in Quinn are grounded emitter amplifiers. Applicant respectfully disagrees.

In the previous Office Actions, the Examiner took the position that in small signal analysis the grounded base amplifiers (78,80) of Quinn are AC grounded. In addition, even if the emitters of a pair of transistors (100, 102) of Quinn are grounded in small signal analysis, the transistors (100, 102) operate differently than the grounded emitter amplifiers of the claimed invention. For instance, when a relatively large input signal to one of the transistors, the maximum currents of the transistors are determined by a current source (105). In other words, a current more than the current determined by the current source (a05) does not flow in the transistors (100, 102). Therefore, when a relatively large input signal is applied to one of the amplifiers (100, 102), it is not possible to obtain a large output signal corresponding to the large input signal, which makes it unable to improve the linearity of the output signal. Also, the lack of linearity of the output signal makes it unable to improve the balance of differential output signals even if the outputs of the transistors (100, 102) and the outputs of the transistors (78,80) are cross-coupled.

In contrast, in the claimed invention, a current flowing in one of the amplifiers

increases as an input voltage increases and is not limited to a predetermined current as determined by the current source (105) of Quinn. Thus, in the present invention, when a relatively large input signal is applied to one of the grounded emitter amplifiers, a base biased voltage (bias point or operational point) increases due to the large input signal, thereby increasing the current flowing the amplifier. Accordingly, even if an idle current, which is based on a biased voltage is relatively small, the current increases due to a self-biasing effect when a large input signal is applied, thereby obtaining a large output signal. That is, employing the grounded emitter amplifiers improves the linearity of the output signal .

In addition, Quinn does not teach or suggest using a single-end differential converter that includes grounded emitter amplifiers with a single-end configuration in which two single-end amplifiers operate by differential inputs. Also, Quinn does not teach or suggest that each grounded emitter amplifier includes a resistor connected between an emitter of a transistor and a ground. Therefore, it is submitted that Quinn neither teaches nor suggests all the features recited in claim 1.

Claim 7 was rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Quinn. Applicant respectfully traverses this rejection.

It is submitted that the combination of the applied references neither teach nor suggest all the features recited in claim 7. It is apparent from the above analysis, the applied references fail to teach or suggest the grounded emitter amplifiers as claimed in the present invention. Therefore, Applicant requests the withdrawal of the rejection of claim 7 under 35 U.S.C. 103(a).

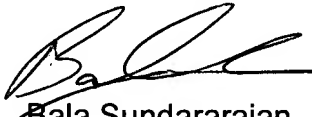
In view of the above amendments and distinctions discussed above, Applicant

requests the withdrawal of the rejection of claims 1, 2, and 7. Claims 1, 3-5, and 7 are amended. No new matter is added. Therefore, Applicant submits that the application is now in condition for allowance with claims 1-8 contained therein.

Please charge any fee deficiency or credit any overpayment to Deposit Account No. 01-2300.

Respectfully submitted,

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Enclosure: Petition for Extension of Time